

CLAIMS

1. A method for removing liquid from at least one flat surface of said substrate, said method comprising the steps of:

5 introducing said substrate in a tank;  
filling said tank with a liquid;  
performing at least one liquid treatment step on said substrate; and  
removing said substrate from said tank in an essentially vertical direction, said direction being parallel to said substrate surfaces that are to be dried, through an opening in  
10 a top part of said tank, so that a liquid flow out of said tank is produced between said substrate and said opening during the passage of said substrate through said opening.

2. A method according to claim 1, further comprising the step of directing a flow of a gaseous substance at an intersection line between said substrate surface that is to be dried and said liquid, in such a way that a plane comprising both the speed vector of the  
15 substrate movement and of said flow of a gaseous substance is perpendicular to said surface of said substrate that is to be dried, the step of directing a flow of a gaseous substance being performed simultaneously with said step of removing said substrate.

3. A method according to claim 1, wherein said step of filling said tank occurs before said step of introducing said substrate.

20 4. A method according to claim 1, wherein said step of filling said tank occurs after said step of introducing said substrate.

5. A method according to claim 1, wherein the liquid treatment step is selected from the group consisting of wet etching step, wet cleaning step and wet rinsing step.

25 6. A method according to claim 2, wherein said substrate has parallel flat surfaces,

wherein said flow of a gaseous substance is produced through a narrow opening of a device positioned in such a way that said narrow opening is parallel to said flat surfaces, and

wherein speed, pressure and direction of said flow is equal in each point of said narrow opening.

7. A method according to claim 6, wherein said gaseous substance is selected from the group consisting of a non-heated tensio-active gas, a heated tensio-active gas, a  
5 non-heated tensio-active vapor, a heated tensio-active vapor, a heated inert gas, and a mixture of at least two of the preceding gaseous substances.

8. A method for removing liquid from at least one surface of said substrate, said method comprising the steps of:

10 introducing said substrate in a tank;  
filling said tank with a liquid;  
performing at least one liquid treatment step on said substrate; and  
removing said substrate from said tank in an essentially vertical direction, said direction being parallel to said substrate surfaces that are to be dried, through an opening in the top part of said tank, so that a liquid flow out of said tank is produced between said  
15 substrate and said opening during the passage of said substrate through said opening.

9. A method according to claim 8, further comprising the step of directing a heat supply at the intersection line between a substrate surface that is to be dried, and said liquid, said heat supply being produced along a line perpendicular to the substrate movement, in such a way that the same heat is produced in every point of said line, the step  
20 of directing a heat supply being performed simultaneously with said step of removing said substrate.

10. A method according to claim 8, wherein said step of filling said tank occurs before said step of introducing said substrate.

11. A method according to claim 8, wherein said step of filling said tank occurs  
25 after said step of introducing said substrate.

12. A method according to claim 9, wherein said substrate has two parallel flat surfaces, and

wherein during the removal of said substrate, a flow of liquid takes place between said flat surfaces and the sides of said opening neighboring said flat surfaces, so that in at

least one cross section perpendicular to the substrate surfaces, said flow is uni-directional and essentially non-turbulent.

13. A method according to claim 12, wherein the liquid is water, wherein the substrate is a hydrophilic silicon substrate,  
5 wherein the water is at room temperature, and wherein speed at which the substrate is removed from the liquid is constant and at least equal to 15 mm/s.

14. A method according to claim 12, wherein speed at which the substrate is removed from the liquid is reduced prior to when a last part of the substrate passes through  
10 the opening.

15. A method according to claim 14, further comprising the step of bringing the last part of said substrate into contact with an object, in order to remove a last droplet attached to said last part.

16. A method according to claim 15, further comprising the step of holding said  
15 substrate after removal from said substrate from said tank, and directing a flow of a gaseous substance essentially parallel to the surfaces of said substrate that are to be dried.

17. An apparatus for liquid treating and drying at least one flat semiconductor substrate, said apparatus comprising in combination:

a tank, said tank comprising a wall with at least one hole and comprising at least  
20 one opening in a top section of said tank, said opening allowing passage of said substrate in a direction parallel to the plane of said substrate, said tank on the outside further comprising a gutter and a drain, the gutter on at least a portion of the tank, the drain connected to said gutter;

means for moving said substrate into said tank; and  
25 means for moving said substrate out of said tank through said opening in an essentially vertical direction.

18. An apparatus according to claim 17, further comprising:  
means for producing a flow of a gaseous substance through a narrow opening parallel to said substrate, said flow being directed at at least one intersection line between a

substrate and a liquid present in said tank, as said substrate is moved out of said tank through said opening, said flow having essentially the same speed and pressure in every point of said narrow opening.

19. An apparatus according to claim 17, wherein one substrate is treated;  
5 wherein the sides of said opening are parallel to said substrate; and  
wherein the width of said opening is at least twice the thickness of said substrate.
20. An apparatus according to claim 17, wherein the means for moving said substrate into said tank and the means for moving said substrate out of said tank through said opening include a support and at least one gripper.
- 10 21. An apparatus according to claim 17, wherein the gutter surrounds the tank.
22. An apparatus for liquid treating and drying at least one flat semiconductor substrate, said apparatus comprising in combination:
  - a tank, said tank comprising in its wall at least one hole and comprising at least one opening in a top section of said tank, said opening allowing the passage of said substrate in
  - 15 a direction parallel to the plane of said substrate, said tank on the outside further comprising a gutter and a drain, the gutter on at least a portion of the tank, the drain connected to said gutter;
  - means for moving said substrate into said tank; and
  - means for moving said substrate out of said tank through said opening in an
  - 20 essentially vertical direction.
23. An apparatus according to claim 22, further comprising:
  - means for directing a heat supply at at least one intersection line between said substrate and a liquid present in said tank, as said substrate is moved out of said tank through said opening, said heat supply having essentially the same intensity in every point
  - 25 along a line which is parallel to said substrate.
24. An apparatus according to claim 22, wherein one substrate is treated;  
wherein the sides of said opening are parallel to said substrate; and  
wherein the width of said opening is at least twice the thickness of said substrate

25. An apparatus according to claim 24, wherein the top section of the tank forms a converging channel; and

wherein a liquid may flow out of the tank and towards said opening.

26. An apparatus according to claim 25, wherein said means for directing a flow 5 of gaseous substance comprises at least one nozzle producing said flow of gaseous substance through a narrow slit which is parallel to the substrate surfaces and whose length is at least equal to that of said intersection line.

27. An apparatus according to claim 25, wherein said means for directing a flow 10 of gaseous substance comprises a container placed above said tank, said container comprising an opening at its bottom so that a substrate can move along a straight line from said tank to said container through said openings, said container further comprising at least one inlet opening for letting in a flow of a gaseous substance.

28. An apparatus according to claim 27, wherein said opening of said container 15 faces said opening of said tank.

29. An apparatus according to claim 27, wherein a first gaseous substance is introduced in said container through at least one first hole in the top part of said container, wherein a second gaseous substance is introduced through at least one long and narrow opening in the lower part of at least one side wall of said container, said long and narrow opening being in the direction of the tank, and

20 wherein a part of the container under said at least one long and narrow opening forms a channel with a converging width, as seen in a cross section perpendicular to the center line of the openings through which the substrate moves.

30. An apparatus according to claim 29, further comprising an exhaust channel for removing said gaseous substance from said intersection line between said substrate and 25 said liquid.

31. An apparatus according to claim 30, wherein sides of said exhaust channel are sealed off from the surrounding atmosphere.

32. An apparatus according to claim 22, wherein the gutter surrounds the tank.

33. An apparatus for treating and drying a flexible substrate according to the method of claim 1, said apparatus comprising a tank, said tank comprises at least one transporting device for transporting said flexible substrate through a liquid inside said tank.

34. An apparatus according to claim 33, wherein said substrate is chosen from 5 the group consisting of a film, a foil, a tape, a wire, and a plurality of parallel wires.

35. An apparatus for treating and drying a batch of parallel flat substrates according to the method of claim 1, comprising a tank, at least one gutter, and at least one drain, wherein said liquid flows out of said tank only between the short edges of said substrates and the neighboring sides of said tank.

10 36. An apparatus according to claim 35, further comprising means for removing a last droplet attached to the last part of said substrate that leaves said liquid, said means for removing a last droplet being chosen from the group consisting of at least one fiber attached to the top part of said tank and at least one piece of foam attached to the top part of said tank.

15 37. An apparatus according to claim 36, wherein movement of said means for removing a last droplet is controlled.